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L. O. HOWARD, Entomologist and Chief of Bureau.

SACBROOD,
A DISEASE OF BEES.

BY

G. F. WHITE, M. D., PH. D.,
Expert in Bacteriology.

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L. O. HOWARD, Entomologist and Chief of Bureau.

SACBROOD,[1] A DISEASE OF BEES.

By G. F. WHITE, M. D., Ph. D., *Expert in Bacteriology.*

INTRODUCTION.

The purpose of this preliminary paper is to discuss briefly a disease, which has been recognized by the bee keepers for many years as dead brood, that is different from foul brood.

Sacbrood, therefore, is no new disease. Samples of it have been received from all the States except three, together with samples from Canada. This disease really has had no name. In recent years many bee keepers have by mistake spoken of it as "pickled brood." The pickled brood as William R. Howard describes it, however, is a very different disease. Before considering sacbrood it might be well to explain briefly what is meant by pickled brood.

PICKLED BROOD.

In 1896 William R. Howard, of Texas, wrote a paper in which he describes a disease of bees that he calls "pickled brood." He declared in his paper that the disease was caused by a fungus to which he gave the name *Aspergillus pollini.* In 1898 he wrote a second paper in which he says that the fungus may attack not only the larvæ and pupæ but adult bees as well.

Maassen in 1906 mentioned a disease of bees which he says is caused by a fungus stated by him to be similar to *Aspergillus flavus* and easily isolated from the larvæ, pupæ, and adult bees affected by the disease.

These two men, then, Howard and Maassen, have each written of a disease of bees which they believe to be caused by a fungus. By each it is claimed that the fungus can attack adult bees as well as the larvæ and pupæ. Howard named the disease which he mentioned "pickled brood," and Maassen referred to the disease which at-

[1] This circular will be followed by a bulletin of this bureau in which this disease will be treated more fully.

tracted his attention as an "aspergillusmycosis in bees." The diseases, as described by Howard and Maassen, then, would be called fungous diseases.

If there are any such fungous diseases of bees in the United States they have not yet attracted the attention of the bee keepers. I base this conclusion upon the fact that during my study of bee diseases there has not yet been received from the bee keepers any sample that could be considered a fungous disease. If future investigations demonstrate that there exists a fungous disease like the one Howard has described, then the name "pickled brood" can be used to designate it. When using the term "pickled brood" in the future the possible disease condition described by Howard will be meant.

A DISEASE OF THE BROOD WHICH IS NOT FOUL BROOD.

There is a disease of the brood of bees that has attracted considerable attention among bee keepers that is neither American foul brood, European foul brood, pickled brood, chilled brood, nor starved brood. This disorder of the brood has for many years been recognized by bee keepers as being different from foul brood. Doolittle, of America, in 1881 wrote of a disease which he says is similar to and called foul brood but which is not foul brood. He writes that the larvæ die here and there throughout the brood comb and that the disease may disappear entirely or it may reappear the next season. Jones, of Canada, in 1883 wrote also of a disease which results in a dying of the brood, with appearances similar to foul brood; but he states that the disease is not foul brood. He says that the bees frequently remove the dead brood and that no further trouble ensues. Simmins, of England, in 1887 wrote of dead brood which he says is not foul brood, and describes the difference in appearance between the brood dead of the disease and brood dead of foul brood. He states, furthermore, that the condition is different from chilled brood and that Cheshire did not find any microscopic evidence of disease in larvæ dead of the disease. An editorial in one of the bee journals in 1892 is of particular interest at this point. The editor wrote that he had recently encountered dead brood which did not seem to be infectious and which lacked two decisive symptoms of the real foul brood, viz, the ropiness and the glue-pot odor.

My own study of this dead brood, recognized by the bee keepers as being different from foul brood, was begun in 1902. Eight samples labeled "pickled brood" were received from the bee inspectors of New York State during 1902 and 1903. These samples were examined and were found to be practically free from microorganisms. The results of these examinations were published in January, 1904. Burri, of Switzerland, in 1906 reported the results of the examination of 25 samples of brood material thought by the bee keepers to be

diseased. He placed the results of his examinations under the following headings: "Sour brood," "stinking foul brood," "nonstinking foul brood," and "dead brood free from bacteria." Four of the 25 samples examined contained dead brood free from bacteria and unaccompanied by other diseases. Kürsteiner, of Switzerland, in 1910, in classifying the results obtained from samples examined by him, made the same classification as made by Burri. During the past six years 326 samples of this disease have been received by the Bureau of Entomology and diagnosed in its bacteriological laboratory.

There is, therefore, a disorder attacking the brood of bees in which brood dies, but in which there has not been demonstrated any microorganism to which the cause of the trouble could be attributed. For this disease the name of "sacbrood" is here suggested.

THE NAME SACBROOD.

As stated, my first examination of this dead brood was made in 1902, when samples were received diagnosed by bee keepers as "pickled brood." The fact was easily determined at that time that the disease could not be considered a fungous disease and was therefore not pickled brood. In the past my preference has been to refer to this condition only as the "so-called pickled brood." Since the disease is not pickled brood, it will produce less confusion and be more scientific if the term "pickled brood" be entirely omitted in the name for the disease. Many larvæ dead of this disease can be removed from the cell without rupturing their body wall. When thus removed they have the appearance of a small closed sac. This character suggested the name "sacbrood." The name has the virtue, therefore, of being both appropriate and brief.

THE SYMPTOMS OF SACBROOD.

The strength of a colony in which sacbrood is present is frequently not noticeably diminished. When the brood is badly infected, however, the colony naturally becomes appreciably weakened thereby. The brood dies after the time of capping. The dead larvæ are therefore almost always found extended lengthwise in the cell and lying with the dorsal side against the lower wall. It is not unusual to find many larvæ dead of this disease in uncapped cells. Such brood, however, had been uncapped by the bees after it died. In this disease the cappings are frequently punctured by the bees. Occasionally a capping has a hole through it, indicating that the capping itself had never been completed. A larva dead of this disease loses its normal color and assumes at first a slightly yellowish tint. "Brown" is the most characteristic appearance assumed by the larva during its decay. Various shades are observed. The term "gray" might sometimes appropriately be used to designate it. The form of the larva dead

of this disease changes much less than it does in foul brood. The body wall is not easily broken, as a rule. On this account often the entire larva can be removed from the cell intact. The content of this saclike larva is more or less watery. The head end is usually turned markedly upward. The dried larva or scale is easily removed from the lower side wall. There is practically no odor to the brood combs.

THE INFECTIOUS NATURE AND CAUSE OF SACBROOD.

In the study of samples of this disease received directly from bee keepers no microorganisms have been found, either culturally or microscopically, to which the cause of the disease can be attributed. This fact, together with the fact that the disease often disappears without any great loss to the colony, would tend to indicate that the disease is not infectious. The experimental evidence which I have obtained proves, however, that the disease is infectious.

EXPERIMENTAL WORK WITH SACBROOD.

Evidence has been obtained by me that sacbrood can be transmitted from diseased to healthy brood. Three healthy colonies were inoculated each with diseased material from a different locality, and in each of these three experimental colonies the disease was produced. These results indicated at once that sacbrood is an infectious disease. The microscopical and cultural study of the infected and dead brood in these experimental colonies, as in the case of the diseased brood in samples direct from the apiary, failed to show any organism to which the cause of the disease could be attributed.

This led naturally to a study of the condition to determine whether or not the virus of the disease was so small that it had not been seen. To obtain evidence on this point material containing the virus was filtered, using an earthenware filter. The three colonies in which the disease had been produced experimentally furnished the disease material for the experiments. Larvæ, sick and dead, of sacbrood were picked from the combs, crushed, and diluted with sterile water. This suspension was filtered by the use of the Berkefeld filter. From each of the three diseased colonies a separate filtrate was obtained, which was fed in sirup to healthy colonies. Six colonies were thus fed—two with each of the three separate filtrates. As a result of these inoculations sacbrood with typical symptoms of the disease was produced in all of the six colonies thus fed.

One more experiment will be mentioned at this time. In this the diseased brood used was taken from one of the colonies in which the disease had been produced by feeding filtrate. Disease material from this colony was filtered as before and fed to two healthy colonies,

with the result that sacbrood was produced in each. It might be mentioned here also that other experiments made indicate that the virus is killed by the application of a comparatively small amount of heat.

In 11 colonies, therefore, sacbrood has been produced experimentally by feeding to healthy colonies the virus of this disease. In 8 of the 11 colonies the disease was produced by virus that had passed through the Berkefeld filter. The disease, therefore, which bee keepers have for a long time recognized as being different from either American or European foul brood has now been demonstrated to be an infectious disease that is caused by a filterable virus.

The conclusion to be drawn from this work, therefore, is that sacbrood is an infectious disease of the brood of bees caused by an infecting agent that is so small, or of such a nature, that it will pass through the pores of a Berkefeld filter.

The three principal brood diseases, then, are now all known to be infectious. These diseases are: American foul brood, caused by *Bacillus larvæ;* European foul brood, caused by *Bacillus pluton;* and sacbrood, caused by a filterable virus.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *December 10, 1912.*

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